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Original Article

GENETIC VARIABILITY, CORRELATION AND PATH COEFFICIENT ANALYSIS IN BLACKGRAM (*VIGNA MUNGO* L. HEPPER)

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ABSTRACT

During Kharif-2020, the present study was conducted on 21 blackgram genotypes at the field experimental site of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj to investigate genetic variability, correlation and path coefficient analysis. ANOVA revealed significantly substantial genetic variability for all 21 blackgram genotypes for 13 characters. In terms of average mean seed yield per plant and other characteristics, genotype IPU-94-1 may be the best genotype, followed by genotype IPU-94-2. UH- 10 and BH-82-2. High GCV and PCV was observed in number of seeds per plant (31.59,34.97) followed biological yield per plant (g) (24.49, 27.73). High heritability was recorded for seed index, number of seeds per plant, seed yield per plant, number of primary branches per plant and biological yield per plant. Seed yield per plant exhibited positive and significant correlation with number of primary branches per plant (0.298**, 0.437**), number of clusters per plant (0.500**,0.613**), number of pods per plant (0.384**,0.601**), seed index (0.938**,0.970**) an d biological yield per plant (0.518**,0.616**) at phenotypic level and genotypic level respectively. The highest positive direct effect on grain yield was depicted by harvest index followed by biological yield. Path analysis revealed that direct as well as indirect effect (through each other) biological yield and harvest index were high magnitude. This indicated that seed yield was mainly a product of direct and indirect effects of above two characters Black gram [Vigna mungo (L.) Genetic variability, correlation and path coefficient analysis.

KEYWORDS: Black Gram (Vigna Mungo L.) Genetics Variability, Correlation & Path Coefficient Analysis

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INTRODUCTION

Black gram (*Vigna mungo* (L.) Hepper) is the fourth most important pulse crop in India (Bhareti *et al*., 2011), also known as urd bean, urd or mash bean belongs to family fabaceae and sub family faboideae. It is an important self-pollinating diploid grain legume (Naga *et al.*, 2006) and 2n=22 is a chromosomal number (Dana 1980). Itis mainly grown in tribal areas in various cropping systems such as sequential crop, catch crop, mixed crop besides growing as sole crop under residual moisture condition safter rice harvest, blackgram for 12 percent of the country's total pulse production Blackgram is an erect, fast growing annual herbaceous legume that grows to a height of 30-100 cm. It has a well-developed tap root and stems that branch out widely from the base. The trifoliate leaves have ovate leaflets that are 4-10cm long and 2-7 cm wide. It has 4-10 black or mottled ellipsoid seeds (jansen,2006). This is one of the most significant short-term legume crops for food, fodder, soil conservation, integrated agricultural systems, pasture reclamation, and symbiotic nitrogen fixation. It is still cultivated on marginal lands under conditions and facesterminal drought which affects its productivity to a great extent. It is still grows on marginal soils and is subjected to severe drought, which has a significant impact on its output.

Black gram is grown in India in about 3.38M ha. Area with 1.61MT of production with an average productivity of 474 kg/ha. Rajasthan is the leading state with an area of 0.89M ha. Having production of 0.42 MT and productivity of 473kg/ha. In Uttar Pradesh, it is being cultivated in an area of 0.78Mha with 0.039 MT production along with the productivity of 500kg/ha. Population explosion during the later part of 20^{th} century and earl 21^{st} century has created short fall in food grain availability and related mal-nutritional problems amongst the economically weaker sections.

Despite the fact that it may be grown in any season, the majority of blackgram cultivation takes place during the rabi or late rabi seasons, especially in peninsular India. The ideal temperature range for growth is 27-30 degrees Celsius, and a dry harvest time is preferable since it drives the crop to mature and decreases disease risk. It grows best in moist soils, but not in saline or alkaline conditions. Waterlogging is more common in green gram than in blackgram.

Black gram grain has a contents of protein 25%, a carbohydrate 56%, a fat 2%, a minerals 4%, and a vitamins 0.4 percent (vitamin a, b1 & b3). Inspite of its high nutritional value, its productivity is very low. In blackgram protein is almost 3 times that of cereals. Blackgram meets a large portion of the protein needs of the country's vegetarian population.

However, the productivity of urd bean is very low due to various constraints like Due to common ancestry of numerous excellent genotypes, poor plant type, cultivation in marginal sand hard climate, and vulnerability to diverse biotic and abiotic stresses, there is a limited genetic base. (Ali *et al*., 2006).

The capacity to estimate genetic parameters such as phenotypic and genotypic coefficients of variability, heritability, and genetic progress to determine the inheritance of various quantitative and qualitative traits is a necessity for running an to improve yield and its component qualities through an effective breeding programme, it is vital to understand the type and magnitude of genetic variability in the population. Singh *et al.* (2016).

The correlation coefficient is a measure how closely specific crop characteristics are linked to productivity. The inter-relation of the characters are generally indicated by correlation coefficient estimates, although path analysis allows for the development of new relationships. understanding of cause and of relationships (Wright, 1921). Several high yielding and disease resistant cultivars developed through routine breeding approaches have been released in black gram. Despite this, India's production, area and productivity have remained nearly unchanged for the past 20 years. As a result, the ria a lot of room for genetic improvement in blackgram to produce superior, high-yielding types.

MATERIALS AND METHODS

The experimental material for this study was collected during Kharif 2020 at SHUATS, Prayagraj, Uttar Pradesh, in the department of Genetics and Plant Breeding.

Experimental material of 21 black gram genotypes were sown in RBD in 3 replications, each with 5 rows of each genotype and a length of 1m each. The space between rows and plants were fixed at 30cm and 10cm, respectively. The full prescribed package of procedure was followed in order to develop a healthy crop.

Days to 50% flowering, plant height, primary branches per plant, number of pods per plant, pod length, days to maturity, number of seeds per pod, biological yield, harvest index (percent), seed index, and seed yield per plant were among the 13 quantitative features reported. The observations for das to 50% flowering and das to maturity were made on a plot-by-plot basis.

The formulas were used to compute the various genetic parameters, such as GCV and PCV suggested by Burton (1952), while heritability, GA as 1% mean were calculated by adopting the formulae given by Johnson *et al*., (1955).

RESULTS AND DISCUSSIONS

Table 1 shows the average performance of 20 genotypes, including one check.

The peruasal data demonstrated that the majority of features, such as plant height PLU-99-10 (21.42)- PLU-86-C (35.63) followed by 50% flowering ranged from UH-10 (43.38) to MU-06 (49.313), number of clusters per plant KKM-4 (9.71) to IPU-94- 1(22.06), number of pods per plant IPU-4-1(40.25) to KKM- 4 (24.71), pod length SPS-42 (2.97) to KKM-4 (4.83), biological yield KKM-4 (7.52) to IPU-94-1 (18.93), number of seeds per pod Ajeet- 32-(4.04) to PLU-708 (13.69), days to maturity IPU-95(56.20) to H-1 (67.60), harvest index SPS- 42(40.07) to IC-240-183 (93.35), Seed index KKM- 4 (5.5) to BH-82-2(9.577), Seed yield per plant KKM-4 (5.5) to IPU-94-1(8.95) have a wide variation.

Mean squares due to genotypes were significant for all variables, suggesting a high amount of genetic variability among the genotypes under investigation, as evidenced by ANOVA (Table 2).

For certain features, genotypes showed a wide range of variation *viz.*, plant height PLU-99-10 (21.42)- PLU-86-C (35.63), biological yield KKM-4 (7.52) to IPU-94-1 (18.93), harvest index SPS- 42(40.07) to IC-240-183 (93.35).

With regard to seed yield, genotypes IPU-94-1 and UH-10 appeared to be the best genotypes, followed by UH-10 and BH-82-2.

For all of the characters studied, the PCV was higher than the GCV, indicating that environmental variables were influencing the characters. The present findings are in accordance with the findings of Panigrahi *et al.* (2014), Anu *et al.* (2017), Priyanka *et al. (*2016), Mahesh *et al.* (2017), Gowsalya *et al.* (2016). According to Burton and Devane, the GCV and PCV were classified as low (less than 10%), moderate (10-20%), and high (more than 20%) (1953). The calculated GCV and PCV aided in gaining a better grasp of the genotype-to-genotype variability. Higher magnitude of GCV was recorded for number of seeds per plant (31.59), number of primary branches per plant (25.306) and biological yield (24.497), harvest index (%) (19.778) and number of clusters per plant (18.424), seed yield per plant (14.96), Number of seeds per plant (34.978), biological yield (27.732), harvest index percentage (24.025), number of clusters per plant (20.96), and pod length all had the highest magnitude of PCV (17.77).

Plant height (8.182 and 16.467), days to 50% flowering (3.066 and 5.198), number of seeds per plant (31.599 and 34.97), days to maturity (3.586 and 5.105), The number of clusters per plant (18.424 and 20.964) as well as the biological index (24.49 and 27.73) values recorded for GCV and PCV respectively. This suggested that by using selection and hybridization, these qualities may be improved for breeding high- yielding cultivars.

The broad sense heritability for the traits under study ranged from 24.7 to 89.2 % (Table 3). According to Robinson *et al.*, (1949), broad sense heritability was classified as low (<30%), medium (30% to 60%) and high (>60%). High heritability was observed for seed index, number of seeds per plant, number of primary branches per plant biological yield per plant and number of clusters per plant suggests that these features might be improved simply through selection. Reena *et al.* (2016) and Mohanlal *et al.* (2018) the qualities were also shown to have a high heritability. The traits showing moderate heritability *viz.*, days to 50% flowering, days to 50% pod setting days to Maturity, pod length and could be improved through indirect selections.

Number of major primary branches per plant, biological yield per plant, number of seeds per plant, and harvest index all had higher genetic advance as a percentage of the mean. These findings support Rajashekar et al., (2017) conclusions that genetic advance suggests predicted improvement as a function of selection. In polygenetic traits, it was utilized to estimate the type of gene action. Progress in genetics Genetic has progressed. Low (<10%), moderate (10%-20%), and high (>20%) genetic advancements are classed as low (<10%), moderate (10%-20%), and high (>20 %).

High heritability combined with genetic progress is a winning combination. The harvest index, biological yield per plant, number of pods per plant, and the number of clusters per plant are all factors to consider. Number of major branches per plant, number of pods per plant, pod length, harvest index,biological yield per plant, and seed yield per plant all had high heritability and moderate genetic progress as percent of mean. These findings are consistent with Dharmendra et al findings throughphenotypic selection regardless of season.

The current investigation came to a conclusion based on the mean performance, genotype IPU-94-1 had maximum seed yield per plant (8.95), clusters per plant (22.06), number of primary branches per plant (9.34), pod length (9.57) and seed index (93.55). Performance in terms of seed yield per plant and other parameters taken into account genotypes IPU- 94-1 may be regarded of as the best genotypes for per-plant seed yield, followed by UH-10, BH-82-2, IPU-95-13 and VBN-4.

High heritability coupled with moderate genetic advance as percent of mean were observed for number of primary branches per plant, number of clusters per plant, biological yield and harvest index. Selection of these traits was useful for furtherimprovement in plant breeding programme.

Studies on correlation association between traits showed that the results are presented in Table 4 and Table 5. Seed yield per plant had significant and positive association with number of primary branches (0.298, 0.437), number of clusters per plant (0.500, 0.613), number of pods per plant (0.384, 0.601), seed index (0.938, 0.970) and biological yield (0.518, 0,616) and also significant and negative association with days to 50% flowering (0.035,0.046), plant height (0.78,0.198), number of seeds per plant (0.195,0.217) at both phenotypic and genotypic level respectively.

Another study found a similar positive and Significant for plant height, number of clusters per plant, and number of pods per plant (Sushmitharaj *et al*., 2018); number of primary branches per plant and hundred seed weight (Kerthiga *et al*., 2018).

The characters' paths were identified using path analysis. days to 50% flowering, number of primary branches, number of pods per plant, number of seeds per plant, pod length, biological yield and the harvest index at the phenotypic and genotypic levels, there is a positive direct effect on seed yield. These resultswere in accordance with the findings of Konda *et al.* (2008) and Bharti *et al.* (2014). The nature and amount of correlation coefficients, as well as their direct and indirect impacts, lead to the conclusion that simultaneous selection improves black gram seed yield.

In the final result, correlation coefficient analysis concluded that with number of primary branches per plant, number of clusters per plant, number of pods per plant, seed index and biological index showed significant and positive at both genotypic and phenotypic level. Path analysis showed that the number of primary branches per plant, number of pods per plant, number of seeds per plant, pod length, biological yield and harvest index at the phenotypic and genotypic levels, there is a positive direct effect on seed yield.. The route analysis assistsin partitioning the correlation coefficients of yield components with seed yield into direct and indirect impacts, ensuring that an attribute's real contribution as well as its

influence through other features are both taken into account. With all of this in mind, research was conducted on a collection of blackgram genotypes in orderto develop an appropriate selection method for genetic improvement.

Table 1: Following are the Results of an Analysis of Variance (ANOVA) for 13 Quantitative Characters in Blackgram.

SL. NO.	Characters	Mean Sum of Squares		
		Replications (df=2)	Treatments(df=20)	Error(df=40)
1	Days to 50% flowering	4.637	9.734 **	3.742
2	Days to 50% podsetting	1.57	9.71*	4.21
3	Days to maturity	8.59	20.09***	5.12
4	Plant height (cm)	13.39	33.3*	16.78
5	Number of primarybranches per plant	2.15	8.58***	0.69
6	Number of clusters perplant	8.54	29.58***	2.64
7	Number of pods perplant	10.04	46.47***	7.5
8	Number of seeds perplant	0.117	11.58***	0.80
9	Pod length (cm)	1.84	0.84*	220.35
10	Seed index	0.12	4.003***	0.15
11	Biological yield per plant(g)	14.57	32.75***	2.80
12	Harvest index (%)	242.35	525.7***	71.93
13	Seed yield per plant (g)	0.243	4.194***	0.285
*Significance at 5% level, **Significant at 1% level of significance and *** Significant at 0.1% level of significance				

Table 2: Mean Performance of 21 Black Gram Genotypes for 13 Quantitative Character

Sl. No.	Characters	Days to 50% flowering	Days to 50% pod setting	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of clusters per plant	Numberof podsper plant	Number of seedsper plant	Pod length (cm)	Seed index	Biological yield per plant (g)	Harvest index (%)	Seedyield per plant (g)
1	IPU-02-43	47.81	55.097	60.46	28.70	5.867	13.897	29.517	5.633	3.610	6.297	9.813	63.043	6.197
2	PLU-99-10	46.82	53.300	62.80	21.42	7.130	17.403	33.257	6.647	4.153	8.310	13.020	61.817	8.120
3	PLU-86-C	46.22	53.207	63.49	35.63	7.317	16.677	32.743	5.937	4.210	8.720	14.130	61.493	8.617
4	UH-10	43.38	59.140	64.48	28.52	4.627	17.407	36.573	5.623	3.983	9.113	18.593	47.860	8.853
5	KKM-4	43.60	55.067	63.86	32.17	3.687	9.717	24.710	4.927	4.837	5.500	7.523	75.207	5.503
6	PLU-708	47.25	56.913	59.91	28.68	5.190	13.783	30.993	13.693	4.187	6.193	10.237	56.093	5.733
7	Azad-1	43.66	56.217	61.53	26.48	6.960	13.837	33.213	6.500	4.620	7.190	12.140	58.000	6.997
8	IPU-99-18	44.92	54.707	61.04	25.44	3.867	14.917	29.290	4.757	3.733	8.237	9.983	81.727	8.040
9	IC-240-183	47.87	56.280	60.97	29.02	4.800	14.867	29.933	5.447	3.970	8.977	9.387	93.553	8.713
10	BH-82-2	45.36	58.667	62.14	24.18	9.340	20.963	34.337	7.117	4.523	9.577	17.763	49.373	8.763
11	DH-85-23	47.02	58.81	59.55	30.38	4.960	14.343	30.720	6.590	4.773	6.243	10.940	56.673	6.183
12	H-1	45.61	58.10	67.60	32.56	4.660	13.013	30.630	5.140	3.187	8.697	10.230	85.123	8.533
13	VBN-11-016	48.37	56.29	61.20	25.81	6.877	14.323	35.293	4.637	4.303	6.927	11.070	55.407	6.133
14	SPS-42	43.77	57.61	65.88	33.30	4.933	21.693	35.767	5.447	2.970	7.703	16.740	40.070	6.693
15	Ajeet-33	45.20	57.95	65.87	27.54	6.990	14.390	34.607	4.040	4.067	6.657	10.630	60.973	6.473
16	PU-30	47.78	57.81	60.21	31.98	8.970	19.1267	39.350	4.637	3.680	8.227	15.833	58.177	8.190
17	IC-456048	46.63	59.05	62.18	30.13	8.507	17.310	36.740	6.360	4.503	8.810	12.903	62.277	8.023
18	MU-06	49.313	58.51	61.30	29.42	6.710	15.253	35.357	4.603	3.630	8.007	11.173	73.470	8.127
19	IPU-94-1	45.73	56.30	62.64	26.12	6.793	22.063	40.253	6.980	4.600	8.773	18.937	47.317	8.953
20	VBN-4	43.60	58.10	64.91	27.78	7.940	19.860	39.760	5.090	3.207	8.633	16.240	53.297	8.637
21	IPU-95-13	47.88	57.76	56.20	26.84	8.440	16.703	37.057	6.147	4.267	8.533	13.557	64.913	8.730
Mean		46.08	56.90	62.30	28.67	6.408	16.264	33.814	5.998	4.048	7.873	12.897	62.184	7.629
C.V.		4.19	3.60	3.63	14.29	13.004	10.003	8.099	14.997	14.741	4.998	12.997	13.640	7.002
S.E.		1.11	1.18	1.30	2.36	0.481	0.939	1.581	0.519	0.345	0.227	0.968	4.897	0.308
C.D. 5%		3.19	3.38	3.73	6.76	1.375	2.685	4.519	1.484	0.985	0.649	2.766	13.997	0.882
C.D. 1%		4.27	4.53	4.99	9.04	1.840	3.592	6.047	1.986	1.318	0.869	3.702	18.729	1.180
Range Lowest		43.37	53.20	56.20	21.42	3.687	9.717	24.710	4.040	2.970	5.500	7.523	40.070	5.503
Range Highest		49.31	59.14	67.60	35.63	9.340	22.063	40.253	13.693	4.837	9.577	18.937	93.553	8.953

Table 3: Coefficient of Variation, Heritability and Genetic Advance for 13 Characters of Black Gram

Characters	(vg))	(vp)	Coefficient of Variation		Heritability (bs) h^2 (%)	GA	GA as % Mean
			GCV	PCV			
Days to 50 flowering	1.99	5.74	3.06	5.19	34.8	1.71	3.72
Days to 50% podsetting	1.83	6.04	2.37	4.32	30.3	1.53	2.69
Days to maturity	4.99	10.11	3.58	5.10	49.3	3.23	5.18
Plant height (cm)	5.50	22.29	8.18	16.46	24.7	2.40	8.37
Number of primary branches Per plant	2.62	3.32	25.30	28.45	79.1	2.97	46.36
Number of clusters per plant	8.97	11.62	18.42	20.96	77.2	5.42	33.35
Number of podsper plant	12.99	20.49	10.65	13.38	63.4	5.91	17.48
Number of seedsper plant	3.59	4.40	31.59	34.97	81.6	3.52	58.80
Pod length (cm)	0.16	0.51	9.93	17.77	31.2	0.46	11.42
Seed index	1.28	1.43	14.38	15.23	89.2	2.20	27.99
Biological yieldper plant (g)	9.98	12.79	24.49	27.73	78	5.74	44.57
Harvest index(%)	151.25	223.19	19.77	24.02	67.8	20.85	33.54
Seed yield perplant (g)	1.30	1.58	16.52	1.58	82	2.13	27.91
Pg = Phenotypic Variance, Vg = Genotypic Variance, PCV = Phenotypic Coefficient of Variance, GCV =Genotypic Coefficient of Variance, = Heritability (broad sense), GA = Genetic advance							

Table4: Correlation Coefficient between yield and its Associated Traits in Blackgram Genotypes at Phenotypic Level and Genotypical Level

Character		Days to50 flowering	Days to 50% pod setting	Days to maturity	Plant height(cm)	Number of primary branches per plant	Number of clusters perplant	Number of pods per plant	Number of seeds per plant	Pod length (cm)	Seed index	Biological yield per plant(g)	Harvest index (%)	Seed yield per plant (g)
Days to 50 flowering	rp	1.000	0.036	-0.391**	0.050	0.181	-0.054	-0.030	0.054	-0.019	0.022	-0.180	0.183	0.035
	gp	1.000	-0.133	-0.89**	-0.256*	0.354**	-0.212	0.103	0.1544	0.152	-0.105	-0.435**	0.396**	-0.046
Days to 50% podsetting	rp		1.000	0.041	0.019	0.189	0.140	0.3507**	-0.032	-0.066	0.124	0.172	-0.107	0.084
	gp		1.000	0.0692	0.249*	0.233	0.353**	0.549**	-0.005	-0.213	0.262*	0.458**	-0.405*	0.184
Days to maturity	rp			1.000	0.228	-0.176	0.040	0.050	-0.194	-0.243	0.092	0.102	-0.021	0.065
	gp			1.000	0.354**	-0.304*	0.133	-0.040	-0.38**	-0.61**	0.1577	0.204	-0.110	0.062
Plant height(cm)	rp				1.000	-0.250 *	-0.128	-0.124	-0.040	-0.104	-0.081	-0.051	0.042	-0.078
	gp				1.000	-0.256*	-0.195	-0.207	-0.239	-0.533*	-0.212	-0.177	0.193	-0.198
Number of primary branches per plant	rp					1.000	0.439 ***	0.554 ***	-0.020	0.090	0.345 **	0.416 ***	-0.333 **	**0.298***
	gp					1.000	0.579**	0.769**	-0.030	0.177	0.445**	0.510**	- 0.403**	0.437**
Number of clusters per plant	rp						1.000	0.613 ***	-0.006	-0.189	0.594 ***	0.769 ***	-0.520 ***	**0.500****
	gp						1.000	0.911**	0.016	-0.295*	0.682**	0.996**	- 0.694**	0.613**
Number of pods per plant	rp							1.000	-0.085	-0.115	0.412 ***	0.597 ***	-0.429 ***	**0.384****
	gp							1.000	-0.101	-0.273*	0.605**	0.931**	- 0.709**	0.601**
Number of seeds per plant	rp								1.000	0.145	-0.150	0.014	-0.210	-0.195
	gp								1.000	0.416**	-0.173	0.018	-0.275*	-0.217
Pod length(cm)	rp									1.000	-0.187	-0.044	-0.137	-0.162
	gp									1.000	-0.287*	-0.180	-0.036	-0.256*
Seed index	rp										1.000	0.576 ***	0.041	**0.938****
	gp										1.000	0.664**	-0.007	0.970**
Biological yieldPer plant (g)	rp											1.000	-0.732 ***	**0.518****
	gp											1.000	- 0.721**	0.616**
Harvest index (%)	rp												1.000	0.149
	gp												1.000	0.076
Seed yieldper plant(g)	rp													1.000
	gp													1.000
rg= Genotypic correlation coefficient, rp= Phenotypic correlation coefficient., Significance at 5% level, ** Significance at 1% level and *** Significant at 0.1% level of significance														

Table 5: Direct and Indirect Effects between Yield and its Associated Traits in Black Gram Genotypes at Phenotypic Level and Genotypical Level

Character		Days to50% flowering	Days to 50% podsetting	Days to maturity	Plant height	Number of primary branches	Number of clustersper plant	Numberof pods per plant	Number of seeds per pod	Pod length	Seed Index	iological yield	Harvest index	Seed yieldper plant
Days to 50% flowering	rp	**0.0241**	0.0009	-0.0095	0.0012	0.0044	-0.0013	-0.0007	0.0013	-0.0005	0.0005	-0.0043	0.0044	0.0355
	gp	**1.2691**	- 0.1689	-1.1367	- 0.3251	0.4488	-0.2691	0.1314	0.1959	0.1931	-0.1336	-0.5525	0.5029	-0.0465
Days to 50% pod setting	rp	-0.0018	**-0.0501**	-0.0021	- 0.0010	- 0.0095	-0.0070	-0.0176	0.0016	0.0033	-0.0063	-0.0086	0.0054	0.0841
	gp	-0.1727	**1.2972**	0.0898	0.3230	0.3026	0.4575	0.7116	-0.0069	- 0.2763	0.3394	0.5943	-0.5254	0.1845
Days to maturity	rp	0.0044	-0.0005	**-0.0111**	- 0.0025	0.0020	-0.0005	-0.0006	0.0022	0.0027	-0.0010	-0.0011	0.0002	0.0655
	gp	-0.7640	0.2136	**0.9859**	1.0911	-0.9379	0.4108	-0.1263	-1.2009	- 0.8909	0.4868	0.6306	-0.3415	0.0620
Plant height (cm)	rp	-0.0006	-0.0002	-0.0027	**- 0.0117**	0.0029	0.0015	0.0015	0.0005	0.0012	0.0009	0.0006	-0.0005	-0.0786
	gp	0.3305	- 0.3213	-0.4561	**- 1.2900**	0.3296	0.2522	0.2682	0.3085	0.6875	0.2738	0.2285	-0.2490	-0.1981
Number of primary branches	rp	0.0040	0.0042	-0.0039	- 0.0055	**0.0222**	0.0097	0.0123	-0.0005	0.0020	0.0077	0.0092	-0.0074	0.298*
	gp	0.3770	0.2486	-0.3240	- 0.2724	**1.0660**	0.6169	0.8201	-0.0320	0.1886	0.4746	0.5435	-0.4295	0.437**
Number of clusters per plant	rp	0.0018	-0.0045	-0.0013	0.0041	- 0.0142	**-0.0323**	-0.0198	0.0002	0.0061	-0.0192	-0.0249	0.0168	0.500**
	gp	-0.5988	0.9961	0.3760	- 0.5521	1.6346	**0.8242**	0.5725	0.0451	- 0.8334	1.9268	0.8140	-1.9612	0.613**
Number of pods per plant	rp	-0.0022	0.0253	0.0037	- 0.0090	0.0400	0.0443	**0.0721**	-0.0061	-0.0083	0.0298	0.0431	-0.0310	0.384**
	gp	0.0164	0.0869	-0.0065	- 0.0329	0.1219	0.1443	**0.1584**	-0.0161	- 0.0432	0.0958	0.1475	-0.1123	0.601**
Number of seeds per plant	rp	0.0001	-0.0001	-0.0004	- 0.0001	0.0000	0.0000	-0.0002	**0.0021**	0.0003	-0.0003	0.0000	-0.0004	-0.1959
	gp	0.1582	- 0.0054	-0.3987	- 0.2450	-0.0308	0.0163	-0.1041	**1.0245**	0.4258	-0.1778	0.0193	-0.2817	-0.2176
Pod length (cm)	rp	-0.0009	-0.0031	-0.0113	- 0.0048	0.0042	-0.0088	-0.0053	0.0067	**0.0464**	-0.0087	-0.0021	-0.0064	-0.1623
	gp	0.1401	- 0.1961	-0.5642	- 0.4907	0.1629	-0.2717	-0.2512	0.3827	**0.9208**	-0.2646	-0.1658	-0.0338	-0.256*
Seed Index	rp	0.0112	0.0639	0.0474	- 0.0414	0.1768	0.3043	0.2113	-0.0768	-0.0959	**0.5116**	0.2948	0.0210	0.938**
	gp	0.5509	- 0.3693	-0.8257	1.1109	-0.3303	-0.5711	-0.1650	0.9085	0.5044	**-0.9344**	-0.4779	0.0376	0.970**
Biological yield per plant(g)	rp	-0.1238	0.1183	0.0707	- 0.0355	0.2865	0.5290	0.4106	0.0100	-0.0304	0.3960	**0.6872**	-0.5031	0.518**
	gp	-0.1185	0.2292	0.9944	- 0.8618	2.4812	0.8486	0.5315	0.0916	- 0.8760	3.2333	**0.8662**	-0.5085	0.616**
Harvest index (%)	rp	0.1191	-0.0700	-0.0139	0.0278	- 0.2171	-0.3385	-0.2792	-0.1372	-0.0893	0.0267	-0.4764	**0.6508**	0.1499
	gp	0.7655	- 0.8261	-0.7722	0.3468	-0.8116	-0.8459	-0.9466	-0.9186	- 0.2565	-0.0501	-0.9854	**0.9785**	0.0763
Seed yield(kg/ha)	rp	0.0355	0.0841	0.0655	- 0.0786	0.298*	0.500**	0.384**	-0.1959	-0.1623	0.938**	0.518**	0.1499	**1.0000**
	gp	-0.0465	0.1845	0.0620	- 0.1981	0.437**	0.613**	0.601**	-0.2176	- 0.256*	0.970**	0.616**	0.0763	**1.0000**
Partial R^2	rp	0.0009	-0.0042	-0.0007	0.0009	0.0066	-0.0162	0.0277	-0.0004	-0.0075	0.4797	0.3556	0.0976	
	gp	-0.0590	0.2394	0.1913	0.2556	0.4659	0.7318	0.0951	-0.2229	0.2360	-0.0769	0.9989	0.5322	
Residual effect -0.245, rg =Genotypic path coefficient, rp = Phenotypic path coefficient														

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